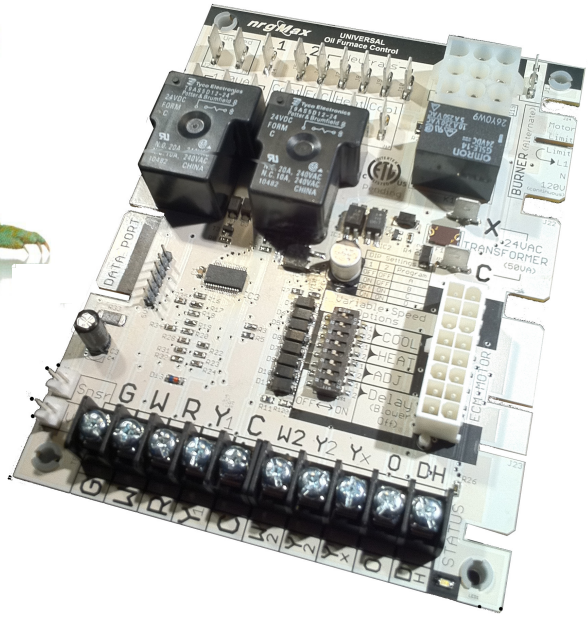
nrgMax

9103i

Advanced Universal Oil Furnace Control

User's Guide



9103i Advanced Universal Oil Furnace Control

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OVERVIEW

The nrgMAX 9103i is the only oil-furnace control you will ever need. It is a feature-rich control designed to meet the needs of modern energy-efficient oil furnaces while still offering backwards compatibility with legacy products.

Mounting in the industry-standard footprint with familiar layout and connections this high quality design meets the needs of an entire industry sector. It eliminates the need for additional controls to accommodate Euro-style burners, and offers an array of variable speed options to suit any requirement.

The control is suitable for use with Direct-Drive PSC motors and ECM motors. ECM motors can be controlled in the common “thermostat-mode” or with other innovative and optional methods. PSC motors are controlled with traditional heavy-duty relay outputs, but can also be controlled in a variable speed method using the optional low-cost plug-in adaptor.

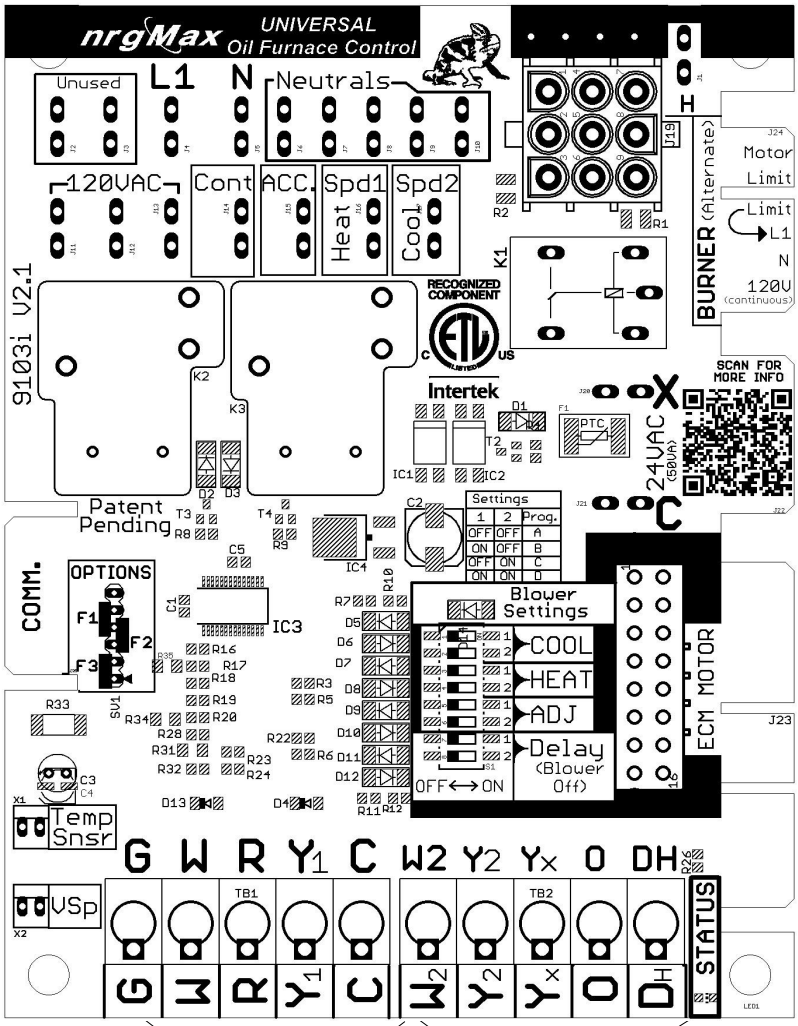
Features

- Industry-standard footprint, mounting and connections
- compatible with American burners (Beckett, Carlin etc) as well as Riello Burners with no additional relays required
- Industry-standard 9-pin burner connection
- 120VAC Connections for:
  - Heat (Speed 1) motor winding
  - Cool (Speed 2) motor winding
  - Electronic Air Cleaner (EAC)
  - Humidifier
  - Continuous Fan
- 24VAC Thermostat Connections for:
  - 5-wire (R,C,W,Y,G), plus
  - W2 (Stage 2 Heating)
  - Y2 (Stage 2 cooling)
  - Yx (dummy connection)
  - O/B (Heat Pump reversing valve)
  - DH (Dehumidification)
- 16-pin connection to GE/Beloit-style ECM Motors
- LED Status indicator
- Solid-State resettable fuse for 50VA Transformer protection
- Double-sided Copper-clad PC board, soldered top and bottom for optimum strength, rigidity and durability
- Multipurpose DIP-switch for field settings

Optional Advanced Features

- Enhanced operation of Standard Direct-Drive PSC Blowers
- Variable speed control of traditional PSC blower motors with plug-in module
- Variable speed control of alternate ECM (Brushless DC) motors using PWM signal
- Variable speed based on DIP-switch Settings or optional plug-in plenum temperature sensor
- Data-port to allow PC communication to view:
  - Status
  - Plenum temperature
  - Thermostat inputs
  - Limit string status
  - Burner status
  - DIP-switch Settings:
- Alternate Burner Connection (for burners with post-purge capability)
- Automatic dehumidification

Features



120VAC Mains Supply connections

120VAC Neutral Connections

Burner 9-pin connector

Humidifier Connection (120VAC)

Terminals for unused blower wires

120VAC outputs to loads and accessories

Heavy duty relays power blowers up to 15Amps

Data Port for Windows® PC diagnostics and troubleshooting

Field-selectable option jumpers

Plug-in port for Optional supply air temperature sensor

Plug-in port for variable speed control of optional motors

Alternate Burner connection with continuous 120VAC

Built-in burner supply relay (powers limit string and burner)

2-D Scan code for rapid access to this user document online via smart-phones

24VAC Transformer input connection. Protected by Solid-state resettable fuse

16-pin connector for ECM Motors

Multipurpose Dip-switch for user settings

Industry-Standard mounting holes and footprint

Standard 5-wire thermostat connections

Extended thermostat connections

Bright LED for status indication

Patents Pending

SPECIFICATIONS

- **Electrical Ratings:**
  - Power Requirements:
    - Voltage: 24Vac, 50/60 Hz.
    - Current: 4 VA at 24 Vac.
    - PTC Fuse (resettable) trips at 4.5A
  - Contact Ratings:
    - Circulating Fan: 15A Full Load, 30A Locked Rotor at 115 Vac (includes optional EAC load).
    - Burner: 5.8 A Continuous Load (7.4A with interrupted ignition)
- **Settings: Standard Configuration**
  - **Heating:**
    - Blower On Delay: 30 seconds, fixed.
    - Blower Off Delay (BOD): 90, 120, 150, 180 seconds, field-adjustable.
  - Timing Tolerance: less than 1 second
- **Environmental Ratings:**
  - Temperature: -40 to +150° F [-40° to +66° C].
  - Humidity: 95% maximum, non-condensing.

Terminals and Connections:

Low Voltage:

- Thermostat:
  - G: Blower On
  - W: Call for heat (0.08A load)
  - R: 24VAC out to thermostat
  - Y1: Cooling, Stage 1
  - C: 24VAC common
  - W2: Heating, Stage 2
  - Y2: Cooling, Stage 2
  - Yx: Dummy terminal, no connection
  - O: Heat pump reversing valve
  - DH: Dehumidification
- Snsr: Plenum Temperature Sensor (Thermistor, 5Kohm @ 25℃ (77℉). (Optional)
- Vsp: Pulse-Width-Modulation (PWM) output to alternate variable speed motors.
  - Brushless DC (BLDC) Mode: 0-5VDC, 80Hz, 0-100% with 0.4% resolution
  - Triac Mode: 60Hz Phase Modulation, ≈70-100% with 5% resolution (Use with triac module)
- **CLASS 2 TRANSFORMER 50VA Max** (overload protected)
  - X: 24VAC
  - C 24VAC Common
- 16-PIN ECM Connector: Convenient interface between 10-position thermostat, DIP-switches and ECM motors.
- Data Port: Edge connect to communication adapter
- Option Jumpers: Selectable Options:
  - F1 Variable Speed PSC Direct Drive Mode (for use with ACC001 PSC Speed Module)
  - F2: Enhanced PSC Direct Drive Mode:

Line Voltage:

- Unused: No connection (2 terminals)
- L1: 120VAC 60Hz, 1ph, 15 A mp (Max) supply
- N: 120VAC Neutral supply
- Neutrals: Connection points for loads, tied internally to N (6 terminals)
- 120VAC : L1 supply to accessories, continuously powered (3 terminals)
- Cont. 120VAC to Continuous speed of blower. Normally energized, it is de-energized whenever Cool or Heat terminals are energized
- EAC: 120VAC to Electronic Air Cleaner. Energized along with Cool or Heat terminals
- Heat-***Spd1:*** 120VAC 15A, 1HP blower speed.
- Cool-***Spd2:*** 120VAC 15A, 1HP blower speed
- H: 120VAC 1A to Humidifier. Powered by burner motor feedback (Pins 7-8 on 9-pin burner connector).

Burner Connections:

- 9-PIN AMP Connector:
  (MATES WITH TYCO PART #350720)
  1) Safety Limit string (return)
  2) 120VAC to Oil Burner (high-limit protected)
  3) Burner T-T (internally connected to Pin 6)
  4) Neutral (internally connected to Pin5 and N)
  5) Neutral (internally connected to Pin 4 and N)
  6) Burner T-T (internally connected to Pin 3)
  7) Burner Motor (internally connected to Pin 8)
  8) Burner Motor (internally connected to Pin 7)
  9) 120VAC to Safety Limit string. Normally off, energized on call for heat by Relay K1
- Edge Connector (Alternate, 6 conductor) mates with Molex 09-01-6061.
  - Motor: Burner Motor
  - Limit: 120VAC to Safety Limit string. Normally off, energized on call for heat by Relay K1
  - Limit: Safety Limit string (return)
  - L1: 120VAC to Oil Burner (high-limit protected)
  - 120V: 120VAC Continuous (not limit protected)INSTALLATION

When Installing this Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings and specifications given in the Instructions and on the product to assure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out the product operation as provided in these instructions.

CAUTION

Disconnect power supply before wiring to prevent electrical shock or equipment damage.

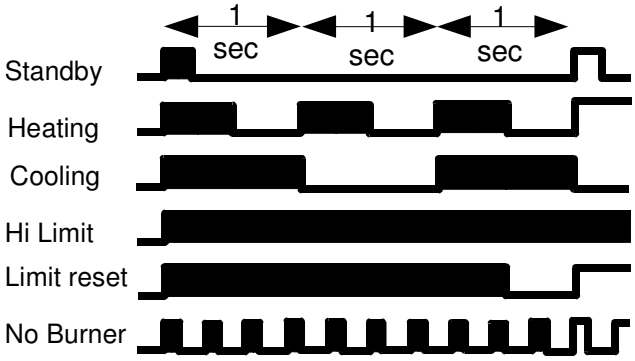
Location and Mounting

The 9103i is mounted in the appliance wiring compartment using four No. 6 screws (obtained locally) through standoffs on the corners of the board.

Wiring

All wiring must comply with local codes and ordinances.
Disconnect power before making wiring connections.

Status LED Flashing Patterns



SETTING OPTIONS WITH JUMPER

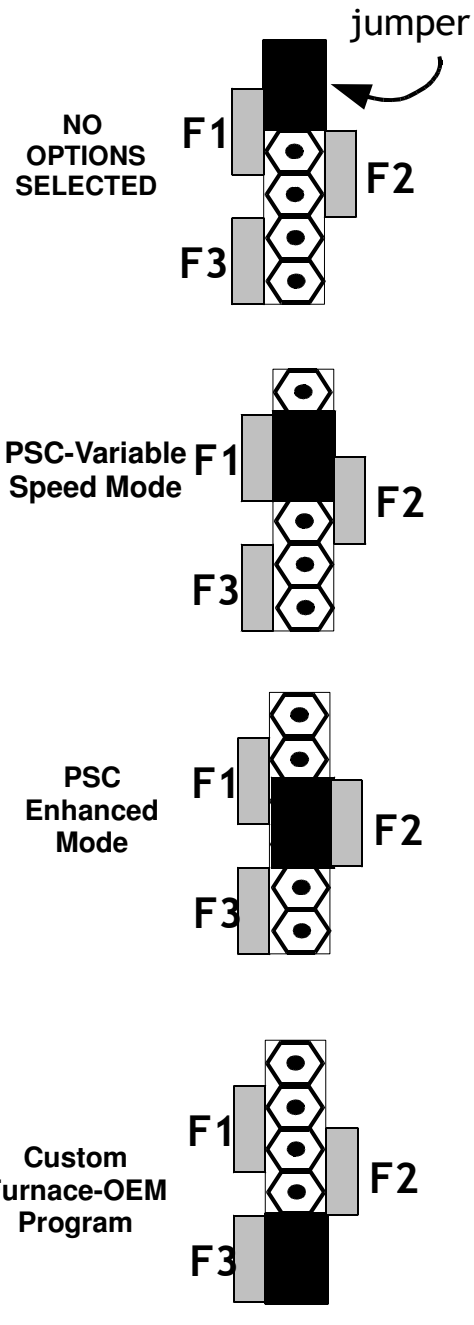
The Option Jumper Pins are located beside the micro-controller chip, above the thermostat G terminal. The factory-default has the jumper in the upper-most position indicating Standard operation (No options enabled). Position F1 enables the variable speed PSC option. F2 enables the Enhanced PSC (Direct Drive) features.
F3 is reserved for OEM-specific customization. See OEM furnace guide for details of this feature.

OPERATIONAL MODES:

All operational modes are simultaneously active on the 9103i, and the user needs only to make the appropriate connections to make use of them. The DIP-Switch is interpreted by the on-board software differently for each mode of operation.

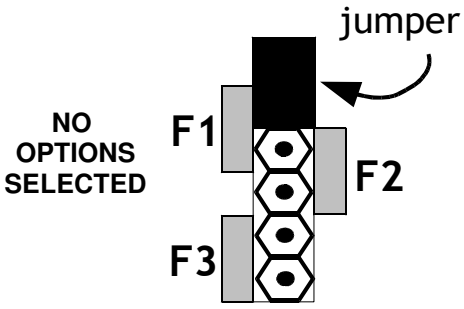
Whenever the optional plenum temperature sensor is used in PSC or BLDC Variable Speed Modes the control immediately recognizes it and will begin to adapt the variable speed operation to Temperature Modulation Mode. If the sensor is unplugged at any time the control reverts back to normal Variable Speed Mode.

Setting Options



Standard PSC (Direct Drive) Mode

- Blower motor is driven by on-board heavy duty relays. Heat, Cool and Continuous speeds are available from 0.250" male spade terminals clearly marked on board. Compatible with all 5+ wire thermostats and responds to:
  - W: heating
  - Y1: cooling
  - Y2: cooling
  - G: Blower On
  - DIP-Switch:
    - Blower Off Delay (BOD):
      - A: 90 Seconds
      - B: 120 Seconds
      - C: 150 Seconds
      - D: 180 Seconds
    - Heat: no function
    - Cool: no function
    - Adj: no function



Option Jumper
For Standard PSC Direct Drive mode ensure that Jumper is in default "No-Option" position

Enhanced PSC (Direct Drive) Mode

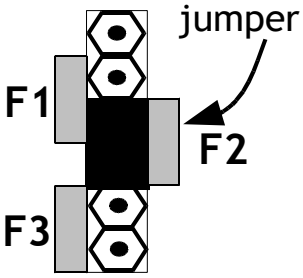
Selected by placing the option jumper across position # F2 on the Option Select pins (See "Setting Options"). All wiring and connections remain the same as the Standard PSC mode, however the operation is enhanced.

ATTENTION:
ENABLE THIS OPTION ONLY WHEN THE COOL-Spd 2 TERMINAL IS CONNECTED TO A HIGHER BLOWER SPEED THAN HEAT-Spd1 OUTPUT.

EXAMPLE:
"HEAT-Spd1" CONNECTED TO MED-HIGH
"COOL-Spd2" CONNECTED TO HIGH

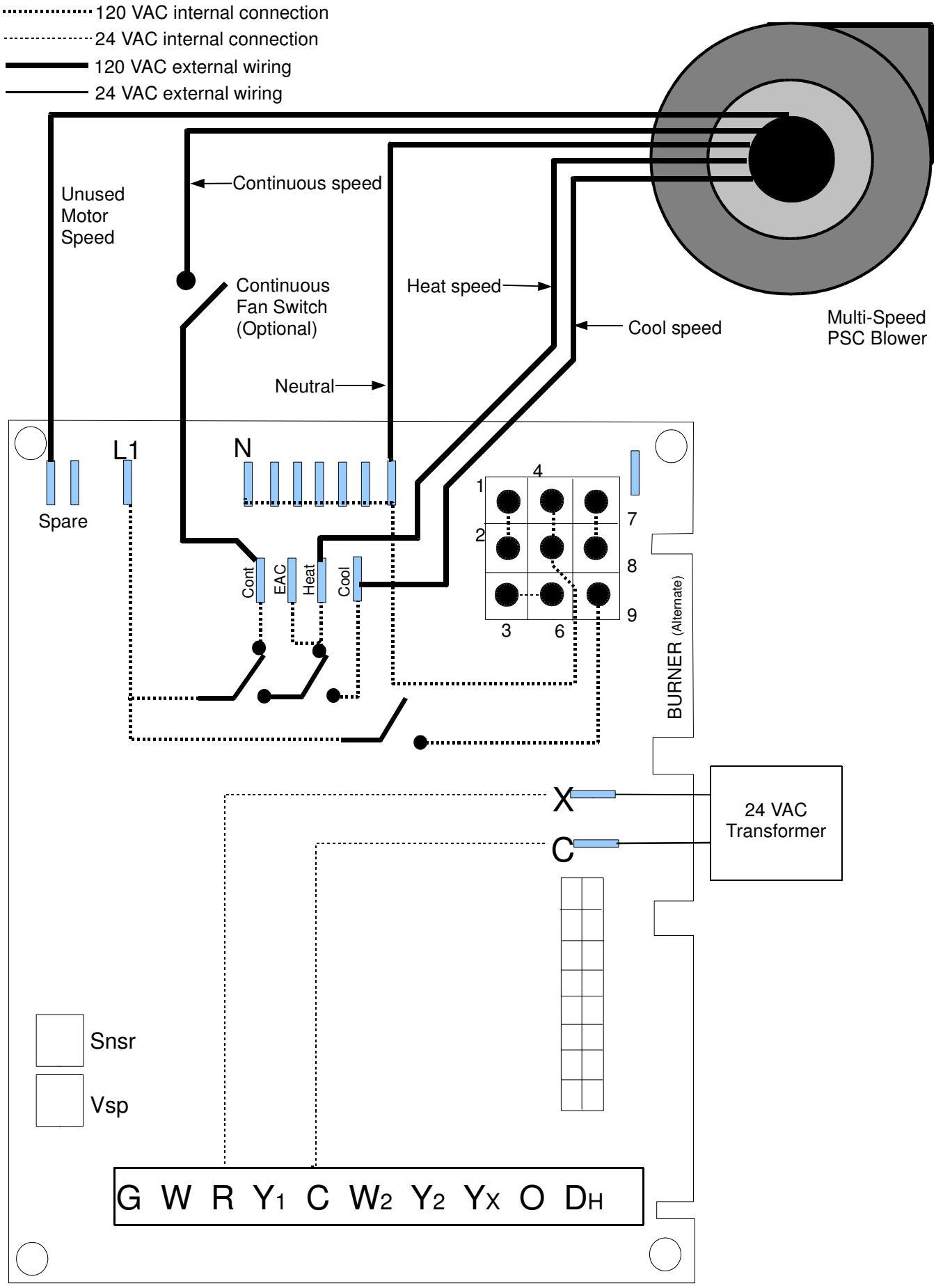
- **Heating:**
  - W (24V signal) activates Lower Speed (Speed1/Heat Speed) output
  - W+W2 (24V signals) activate Higher Speed (Speed2/Cool Speed)
- **Cooling:** Blower is initially started on Lower Speed for 4 minutes to allow for dehumidification, after which the blower switches to Higher Speed. If the the 24VAC signal to the DH terminal opens this signals a call to dehumidify and the blower drops down to Lower Speed to encourage greater condensation across the cooling coil. When the 24VAC signal reappears on DH the blower is switched back up to Higher Speed
  - Y1 (24V signal): 4 minutes at Lower speed to dehumidify, then to Higher speed
  - DH (NO 24V signal): immediately drops from Higher speed to Lower speed to dehumidify.
  - DH (24V signal returns): Blower stepped up to Higher Speed
  - Y2 (24V signal) overrides DH and Y1 keeping Higher Speed energized as long as signal on Y2 is present
  - G (24V signal alone without Y1, Y2, or W): energizes Lower Speed terminal

NOTE: FOR 2-STAGE COOLING IN ENHANCED MODE USE YX AND Y2. YX IS A DUMMY TERMINAL AND IS IGNORED BY THE CONTROL LOGIC BUT PROVIDES A CONVENIENT CONNECTION POINT FOR THE AC COMPRESSOR. WHEN THE THERMOSTAT CALLS FOR STAGE 1 COOLING (A Y1 SIGNAL FROM THE THERMOSTAT) IT IS TERMINATED AT YX, BUT THE THERMOSTAT ALSO ACTIVATES G SIMULTANEOUSLY. THE 9103I THEN ENERGIZES THE LOWER SPEED HEAT TERMINAL AS LONG AS THE CONDITION EXISTS. IF Y2 IS ENERGIZED (TOGETHER WITH Y1/G, OR SEPARATELY) THE CONTROL WILL SWITCH TO THE HIGHEST SPEED. THIS ALLOWS FOR 2 DIFFERENT BLOWER SPEEDS FOR 2-STAGE COOLING



Option Jumper
For Enhanced PSC Direct Drive mode ensure that Jumper is in F2 position

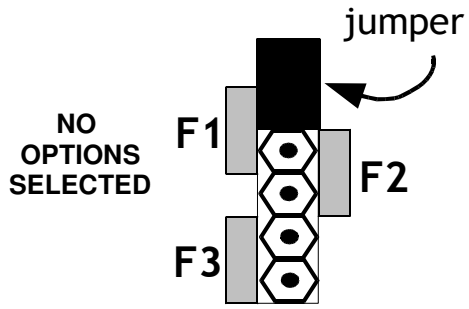
Blower Wiring: Standard and Enhanced PSC (Direct Drive) Modes



ECM Mode:

- **ECM** Motor handles all blower speed logic in factory-set “thermostat mode” and it monitors all ten thermostat inputs. The 9103i control continues to energize the Burner, EAC and H terminals normally. While the DIP-Switch settings are now directed to the ECM motor through the 16-pin connector the 9103i will continue to interpret the BOD settings to establish the delay period before de-energizing EAC terminal. Please note that the OEM factory -settings for the ECM blower-off delay may not co-ordinate with the EAC delay.

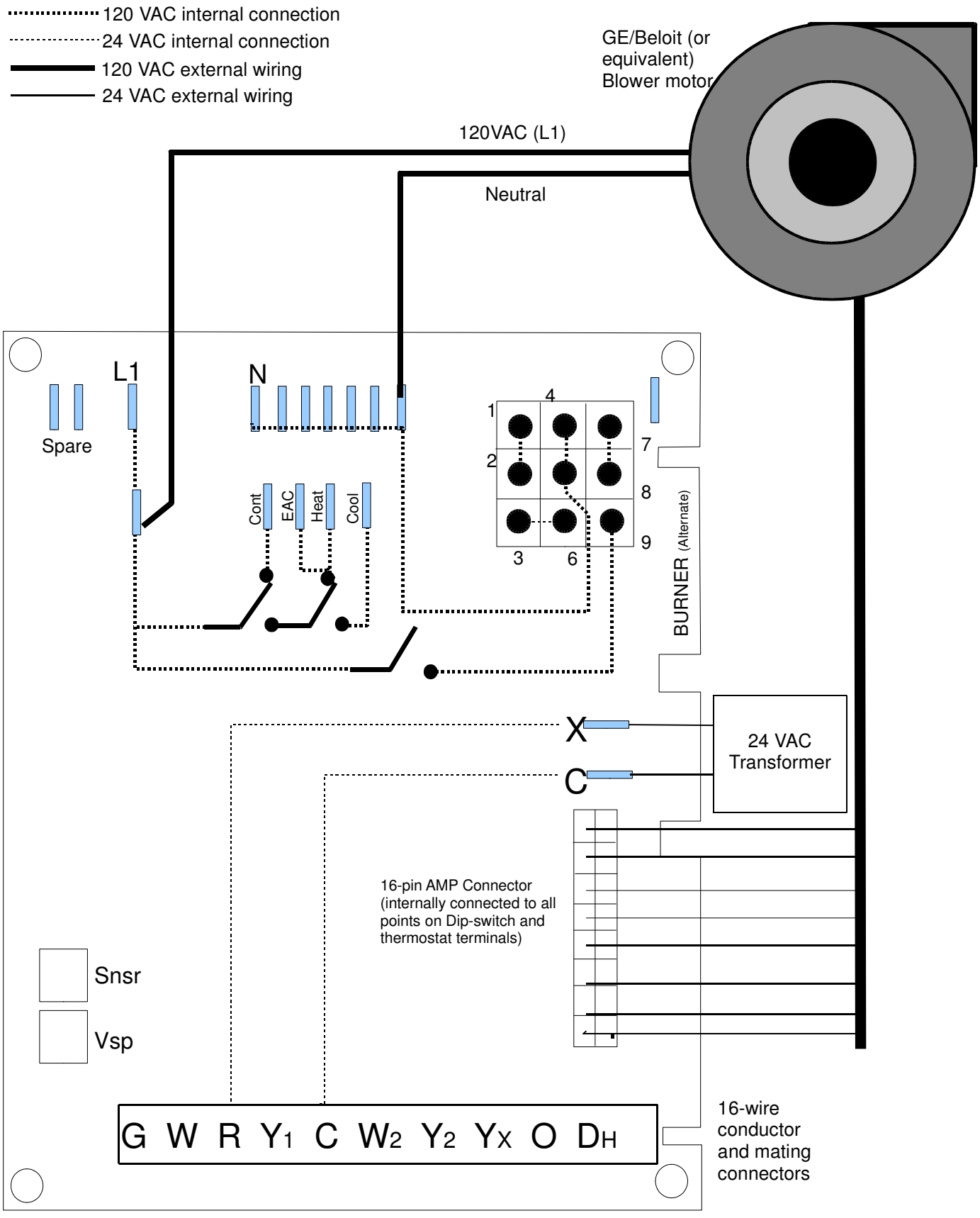
THE 9103I CONTROLLER HAS NO INFLUENCE OVER THE ECM MOTOR AS ALL SIGNALS ARE “PASS-THROUGH” ONLY.



Option Jumper

For ECM mode ensure that Jumper is in default “No-Option” position

Blower Wiring: ECM mode



PSC (Direct Drive) Variable Speed Mode:

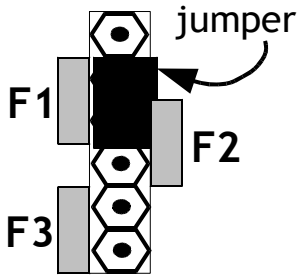
A compatible Direct Drive PSC blower motor is driven by optional plug-in ACC001 PSC Motor Speed Control Module in conjunction with Dip-switch settings. Heat and Cool outputs on the 9103i are routed through the speed control module to the appropriate windings on the blower motor. The module reduces the line voltage delivered to the blower thereby slowing according to the user-selectable Dip Switch settings allowing fine-tuning of blower speed in Heat and Cool operation.

REFER TO SPEED CURVES FOR MORE INFORMATION ON TEMPERATURE-SPEED RELATIONSHIP

Speeds are derived from DIP-switch settings (SEE NOTE 1) . A jumper must be placed on the Option selector pins by connecting Pin 2 and 3 to enable this feature. Compatible with all 5+ wire thermostats and responds to:

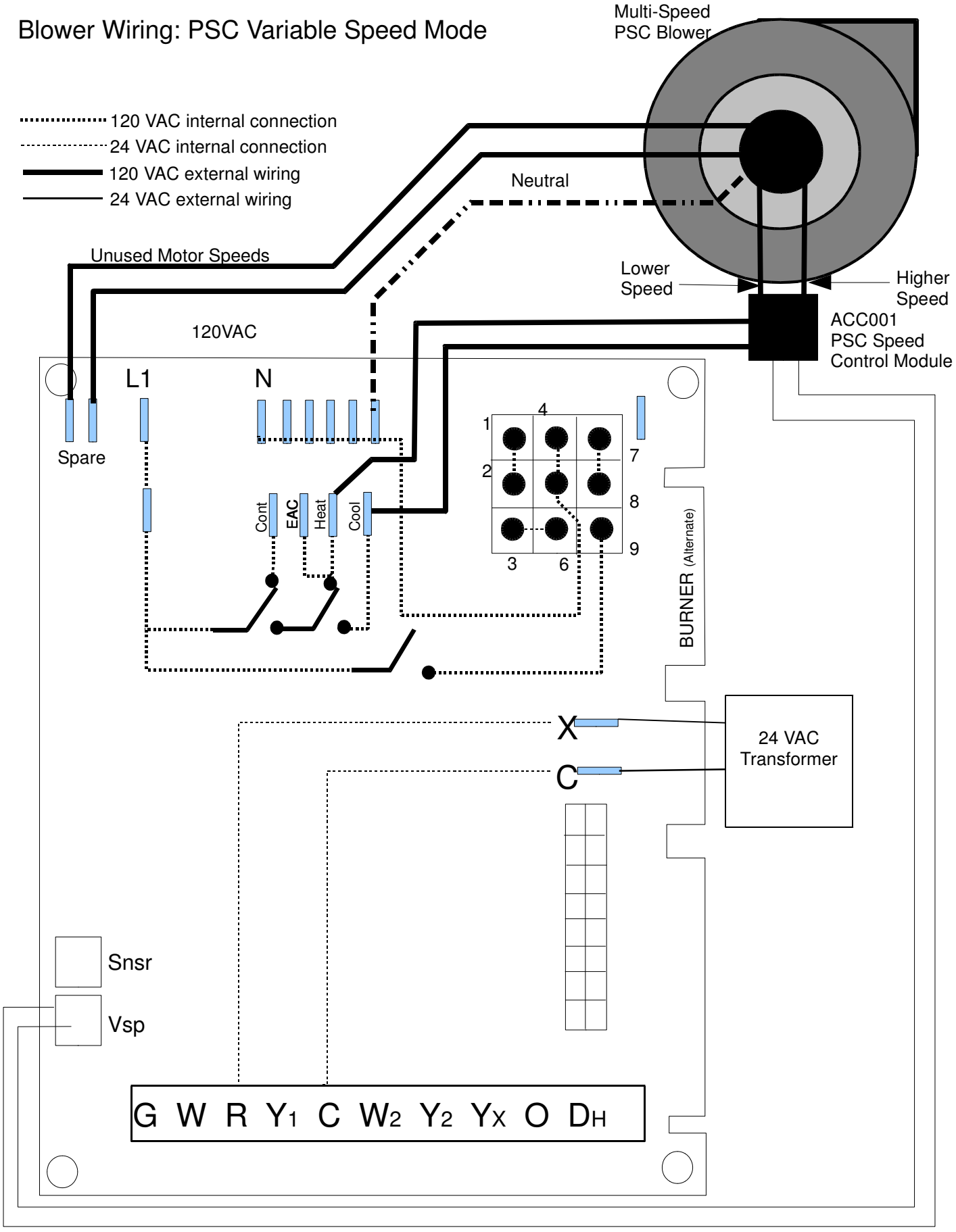
- W: Stage1 heating
- W + W2: Stage 2 heating
- Y: Stage 1 cooling
- Y2: Stage 2 cooling
- G: Blower On
- Dehumidistat
- DIP-Switch:
  - Blower Off Delay (BOD):
    - A: 90 Seconds
    - B: 120 Seconds
    - C: 150 Seconds
    - D: 180 Seconds
  - Heat: (Sets blower speed in heating)
    - A: 100%
    - B: 90%
    - C: 80%
    - D: 70%
  - Cool: (Sets blower speed in cooling)
    - A : 100%
    - B : 90%
    - C : 80%
    - D : 70%
  - Adj: (Fine tunes blower speeds)
    - A No adjust
    - B Heat speed -5%
    - C Cool speed - 5%
    - D Heat and Cool speeds - 5%

NOTE 1: TRIAC SPEED CONTROL OF PSC MOTORS IS APPROXIMATE. THEREFORE FRACTIONAL POWER AND SPEED IS ESTIMATED.



Option Jumper
For PSC Variable Speed mode ensure that Jumper is in F1 position

Blower Wiring: PSC Variable Speed Mode



PSC "eTemp" (Direct Drive) Temperature-Modulation Mode:

A compatible PSC blower motor is driven by optional plug-in ACC001 PSC Motor Speed Control Module in conjunction with a ACC003 Plenum Temperature Sensor. Heat and Cool outputs on the 9103i are routed through the speed control module to the appropriate windings on the blower motor. The module reduces the line voltage delivered to the blower thereby slowing it to maintain a speed-temperature relationship.

Speeds are derived from the delivered air temperature (TARGET TEMPERATURE) as sensed by the plenum sensor and modified by DIP-switch settings.

REFER TO SPEED CURVES FOR MORE INFORMATION ON TEMPERATURE-SPEED RELATIONSHIP

The Heating blower off period is not time dependent, but continues to run until the supply temperature drops below 90 F.

Compatible with all 5+ wire thermostats and responds to:

- W: Stage1 heating
- W + W2: Stage 2 heating
- Y: Stage 1 cooling
- Y2: Stage 2 cooling
- G: Blower On
- Dehumidistat
- DIP-Switch:
  - Blower Off Delay (EAC only)
    - A: 90 Seconds
    - B: 120 Seconds
    - C: 150 Seconds
    - D: 180 Seconds
  - HEAT- 100% blower speed applied at:
    - A: 150 deg F
    - B: 156 deg F
    - C: 162deg F
    - D: 168 deg F
  - COOL- 100% blower speed applied at:
    - A: 34deg F
    - B: 40deg F
    - C: 46deg F
    - D: 52deg F
  - Adj: Fine tunes target temperatures
    - A: Heat= N/C* Cool= N/C*
    - B: Heat= +5F Cool= N/C
    - C: Heat= N/C* Cool= -3F
    - D: Heat= +5F Cool= -3F

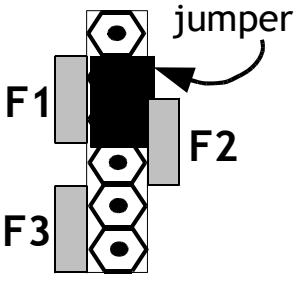
TARGET TEMPERATURES ARE A REFERENCE POINT ON THE SPEED-TEMPERATURE CURVE WHERE THE BLOWER IS SET TO OPERATE AT 100% FULL LINE VOLTAGE.

UNDER NORMAL CIRCUMSTANCES THE BLOWER WILL FIND A STEADY-STATE HEATSPEED AT A TEMPERATURE LOWER THAN THE TARGET, AND FIND A STEADY-STATE COOL SPEED AT A TEMPERATURE HIGHER THAN THE COOLING TARGET TEMPERATURE.

IN COOLING MODE A LOW TEMPERATURE LIMIT OF 45 DEGREES F IS FIXED. IF THE PROBE DETECTS A CHILLED AIR TEMPERATURE BELOW THIS LIMIT THE BLOWER WILL RECIEVE 100% FULL LINE VOLTAGE TO PREVENT DAMAGE TO THE COOLING SYSTEM.

STEADY STATE TEMPERATURES WILL BE DEPENDENT ON VARIABLES SUCH AS LINE VOLTAGE, BLOWER-DESIGN, DUCT WORK, BURNER FIRING-RATE, AC TONNAGE, ETC.

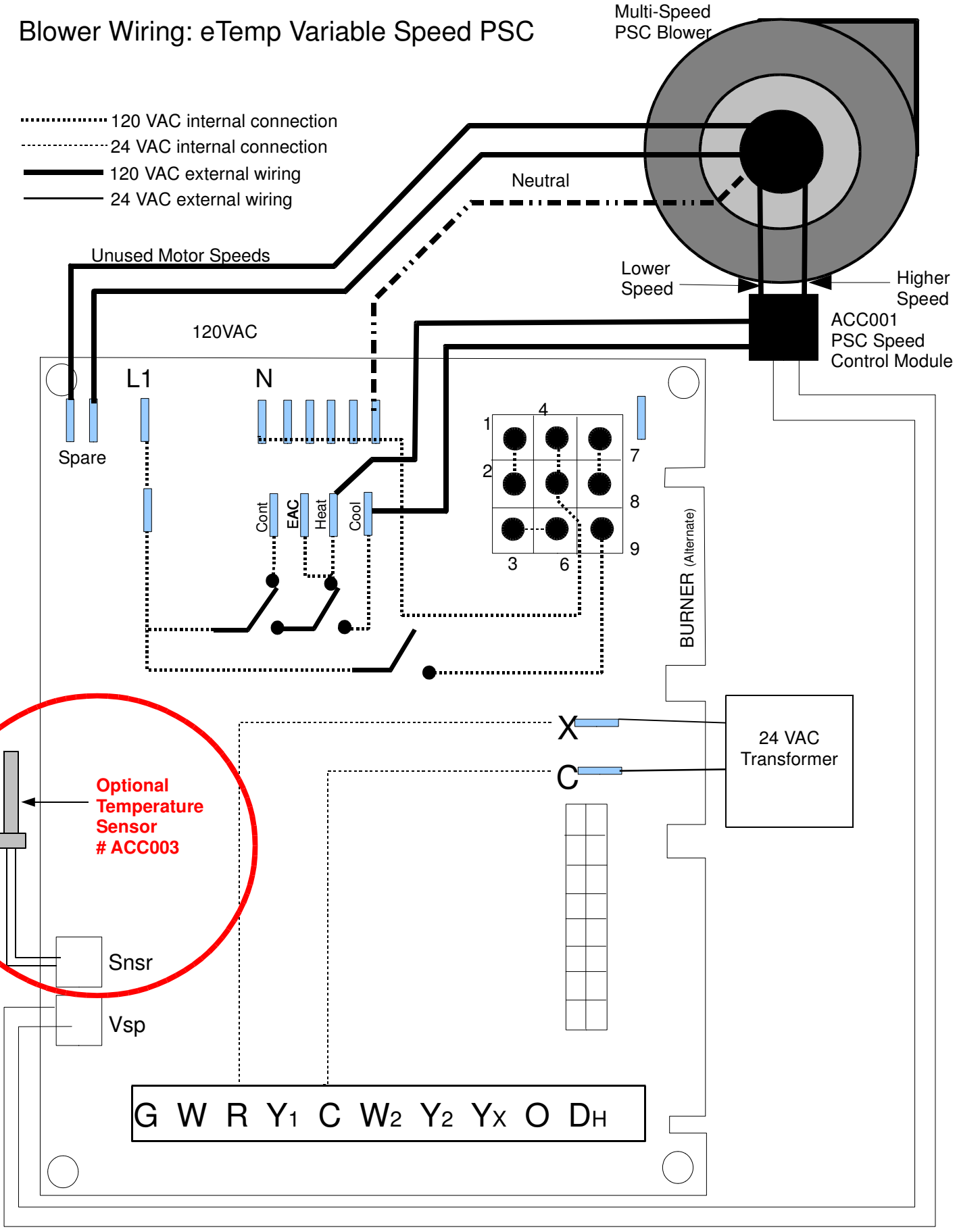
AFTER REACHING A STEADY STATE TEMPERATURE THE INSTALLER SHOULD ADJUST THE DIP-SWITCH SETTINGS TO ACHIEVE THE IDEAL TEMPERATURE FOR THE EQUIPMENT IN BOTH HEATING AND COOLING MODES



Option Jumper
For PSC Variable Speed mode ensure that Jumper is in F1 position

* N/C = No Change

Blower Wiring: eTemp Variable Speed PSC



PWM Variable Speed Mode:

A compatible BLDC (Brushless DC) Blower Motor is driven by a 0 to 5Vdc 80Hz Pulse-width modulated signal from Vsp terminal from 0 to 100% duty cycle, representing 0 to 100% full power to the motor.

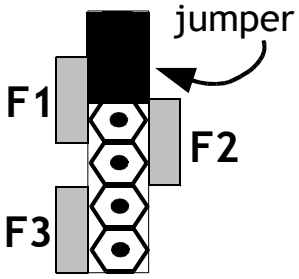
Heat, Cool and Continuous speeds are all derived using this method. Speeds are derived from DIP-switch settings (SEE NOTE 2) . This features is always enabled if there is no option jumper required.

REFER TO SPEED CURVES FOR MORE INFORMATION ON TEMPERATURE-SPEED RELATIONSHIP

Compatible with all 5+ wire thermostats and responds to:

- DIP-Switch
- W: Stage1 heating
- W + W2: Stage 2 heating
- Y: Stage 1 cooling
- Y2: Stage 2 cooling
- G: Blower On
- Dehumidistat
- DIP-Switch:
  - Blower Off Delay (BOD):
    - A: 90 Seconds
    - B: 120 Seconds
    - C: 150 Seconds
    - D: 180 Seconds
  - Heat: (Sets blower speed in heating)
    - A: 30%
    - B: 50%
    - C: 70%
    - D 90%
  - Cool: (Sets blower speed in cooling)
    - A 65%
    - B 75%
    - C 85%
    - D 95%
  - Adj: (Fine tunes blower speeds)
    - A No adjust
    - B Heat speed -10%
    - C Cool speed - 5%
    - D Heat -10% AND Cool -5%

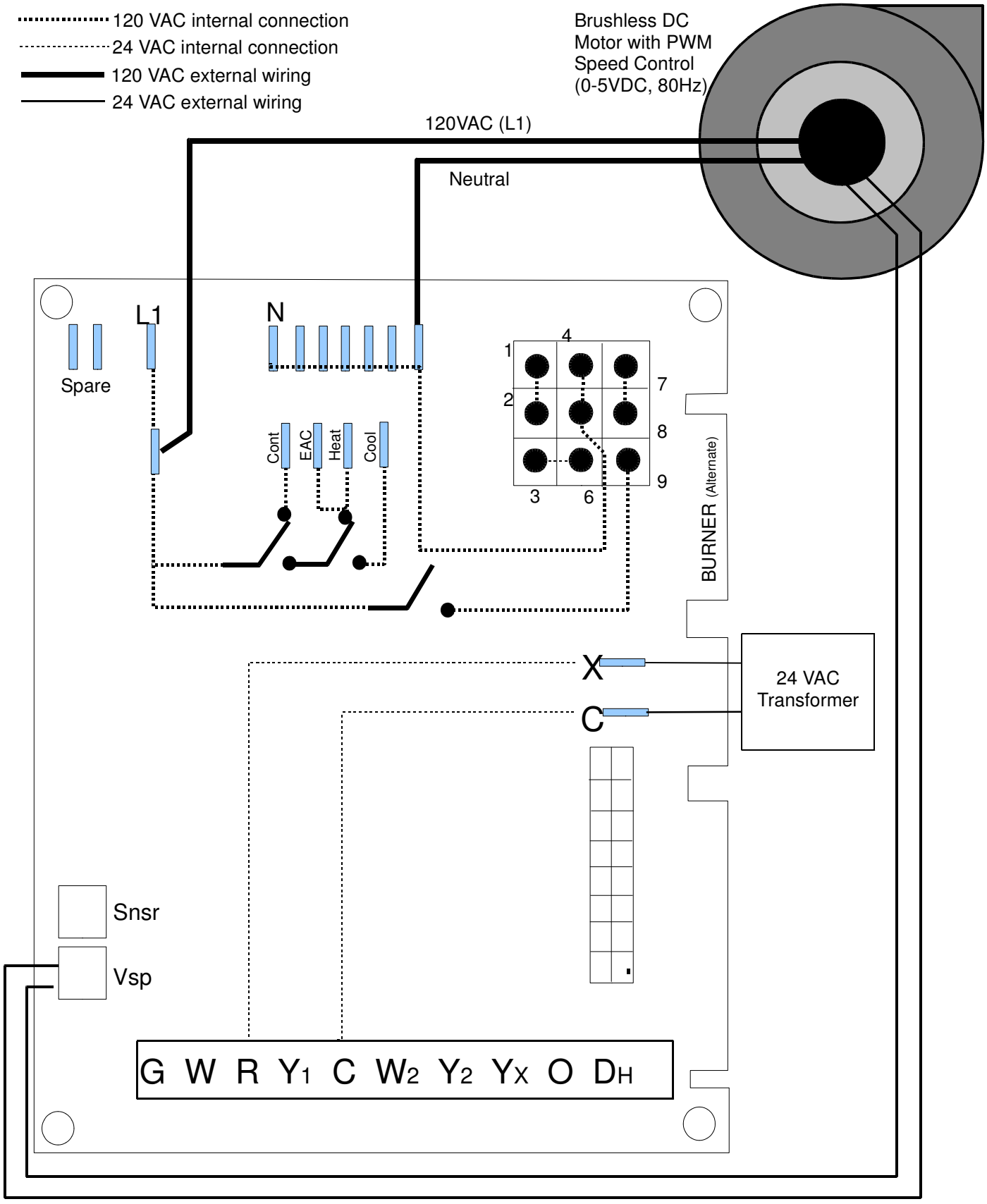
NOTE 2: FAILURE TO PROPERLY INSTALL THE OPTION SELECTOR PINS MAY RESULT IN ERRATIC RESPONSE FROM THE BLDC MOTOR



Option Jumper

For PWM Variable Speed mode for Brushless DC motor ensure that Jumper is in default “no option” position

Blower Wiring: PWM BLDC (Brushless DC Motor) mode



PWM "eTemp" Temperature-Modulation Mode:

A compatible BLDC Blower Motor is driven by a 0 to 5Vdc 80Hz Pulse-width modulated signal from Vsp terminal from 0 to 100% duty cycle, representing 0 to 100% full power to the motor in conjunction with a plenum temperature sensor.

Speeds are derived from the delivered air temperature as sensed by the plenum sensor and modified by DIP-switch settings.

REFER TO SPEED CURVES FOR MORE INFORMATION ON TEMPERATURE-SPEED RELATIONSHIP

The blower off period is not time dependent, but continues to run until the supply temperature drops below 90 F.

Compatible with all 5+ wire thermostats and responds to:

- W: Stage1 heating
- W + W2: Stage 2 heating
- Y: Stage 1 cooling
- Y2: Stage 2 cooling
- G: Blower On
- Dehumidistat
- DIP-Switch:
  - Blower Off Delay (EAC only)
    - A: 90 Seconds
    - B: 120 Seconds
    - C: 150 Seconds
    - D: 180 Seconds
  - HEAT- 100% blower speed applied at:
    - A: 140 deg F
    - B: 150 deg F
    - C: 160 deg F
    - D: 170 deg F
  - COOL- 100% blower speed applied at:
    - A: 55 deg F
    - B: 49 deg F
    - C: 43 deg F
    - D: 37 deg F
  - Adj: Fine tunes target temperatures
    - A: Heat= N/C* Cool= N/C*
    - B: Heat= +5F Cool= N/C
    - C: Heat= N/C* Cool= -3F
    - D: Heat= +5F Cool= -3F

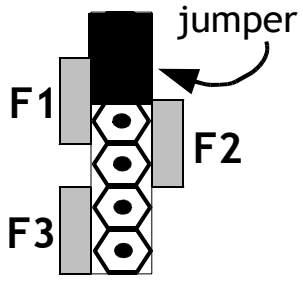
TARGET TEMPERATURES ARE A REFERENCE POINT ON THE SPEED-TEMPERATURE CURVE WHERE THE BLOWER IS SET TO OPERATE AT 100% FULL SPEED.

UNDER NORMAL CIRCUMSTANCES THE BLOWER WILL FIND A STEADY-STATE HEATSPEED AT A TEMPERATURE LOWER THAN THE TARGET AND FIND A STEADY-STATE COOL SPEED AT A TEMPERATURE HIGHER THAN THE COOLING TARGET TEMPERATURE

IN COOLING MODE A LOW TEMPERATURE LIMIT OF 45 DEGREES F IS FIXED. IF THE PROBE DETECTS A CHILLED AIR TEMPERATURE BELOW THIS LIMIT THE BLOWER WILL OPERATE AT 100% FULL SPEED TO PREVENT DAMAGE TO THE COOLING SYSTEM.

STEADY STATE TEMPERATURES WILL BE DEPENDENT ON VARIABLES SUCH AS BLOWER-DESIGN, DUCT WORK, BURNER FIRING-RATE, AC TONNAGE, ETC.

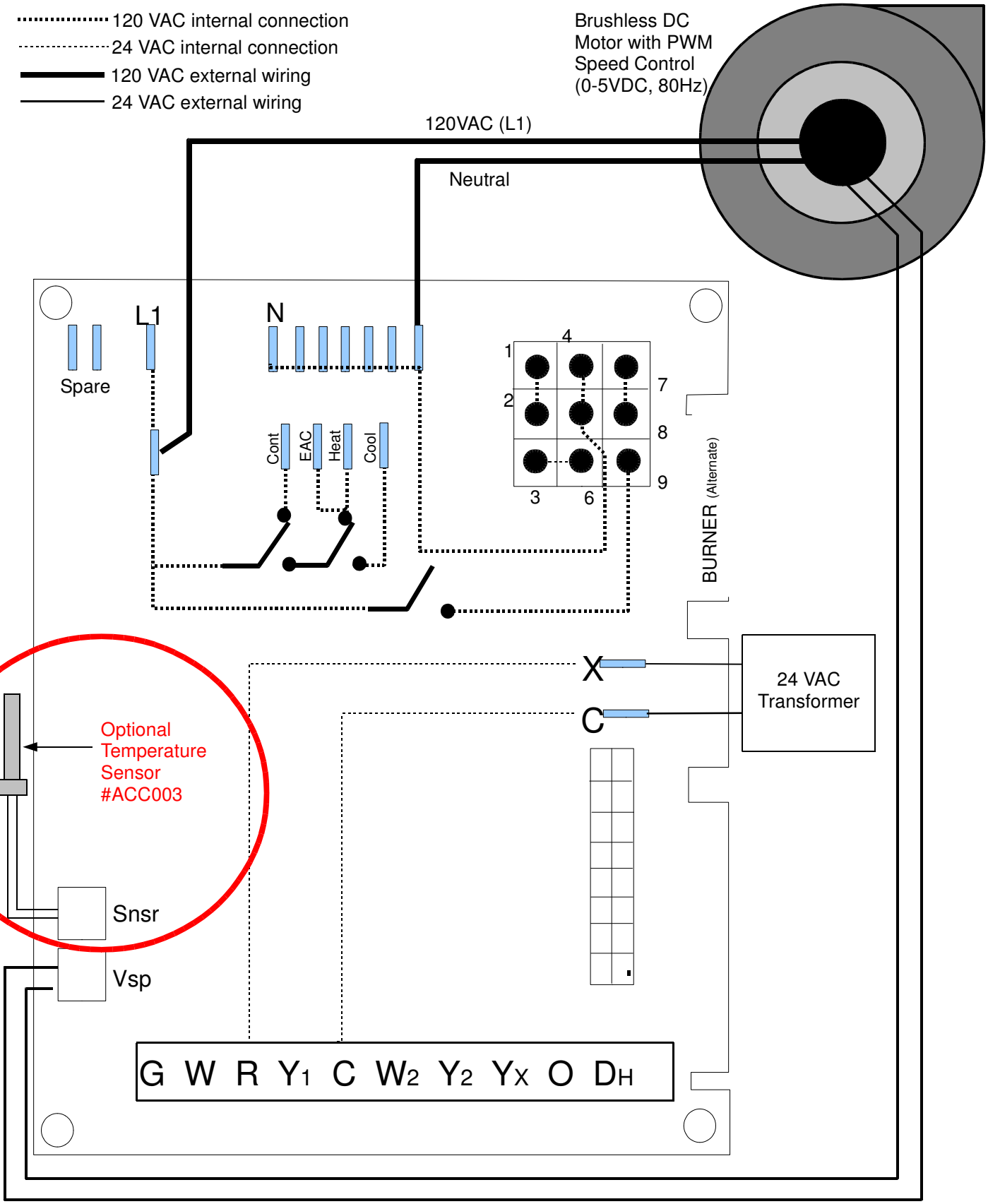
AFTER REACHING A STEADY STATE TEMPERATURE THE INSTALLER SHOULD ADJUST THE DIP-SWITCH SETTINGS TO ACHIEVE THE IDEAL TEMPERATURE FOR THE EQUIPMENT IN BOTH HEATING AND COOLING MODES



Option Jumper
For PWM Variable Speed mode for Brushless DC motor ensure that Jumper is in default "no option" position

* N/C = No Change

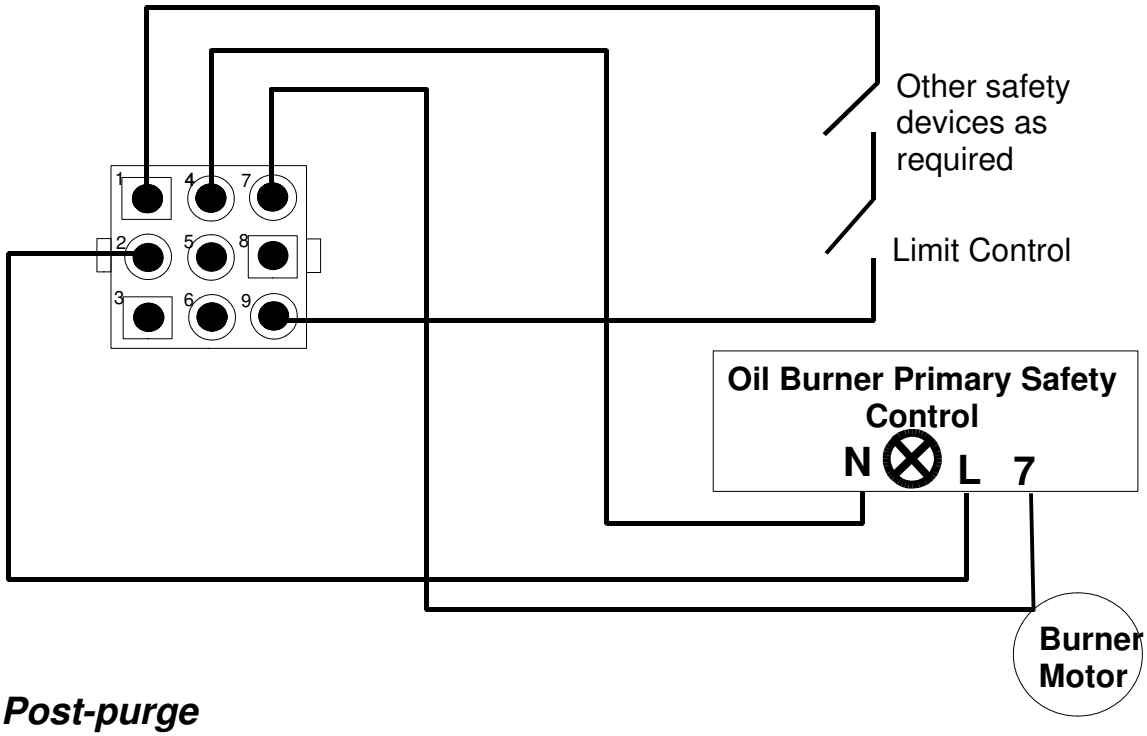
Blower Wiring: PWM eTemp BLDC Temperature Modulation Mode



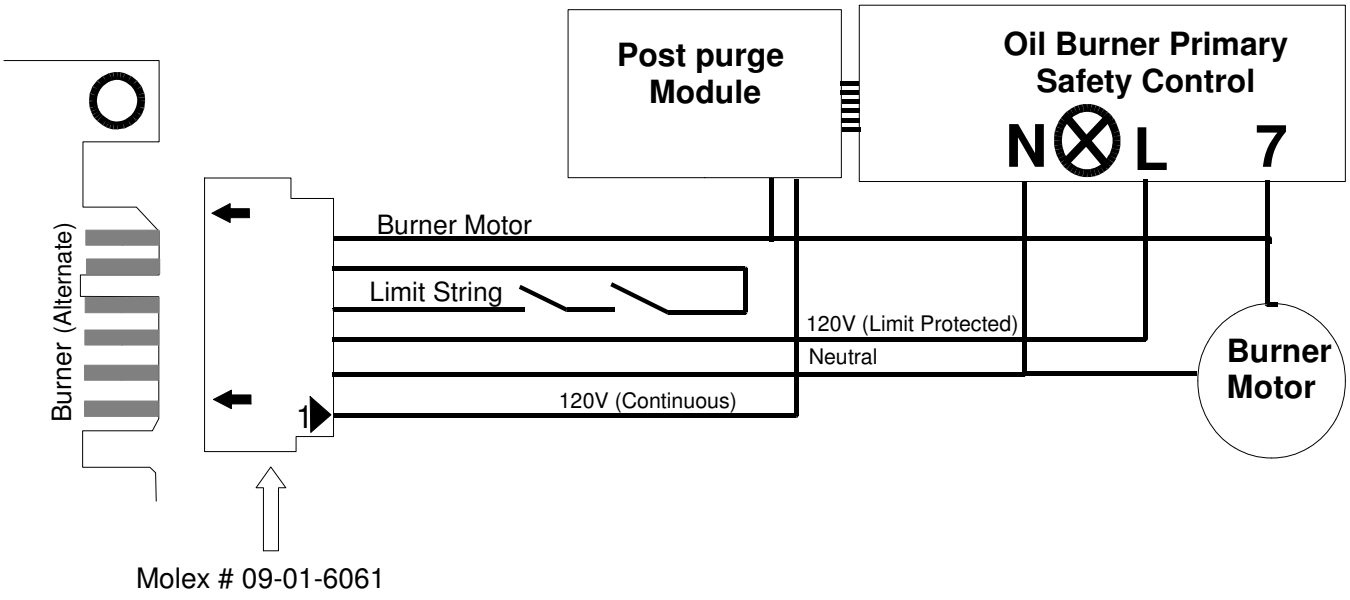
BURNER CONNECTIONS

Riello, with Post-purge module

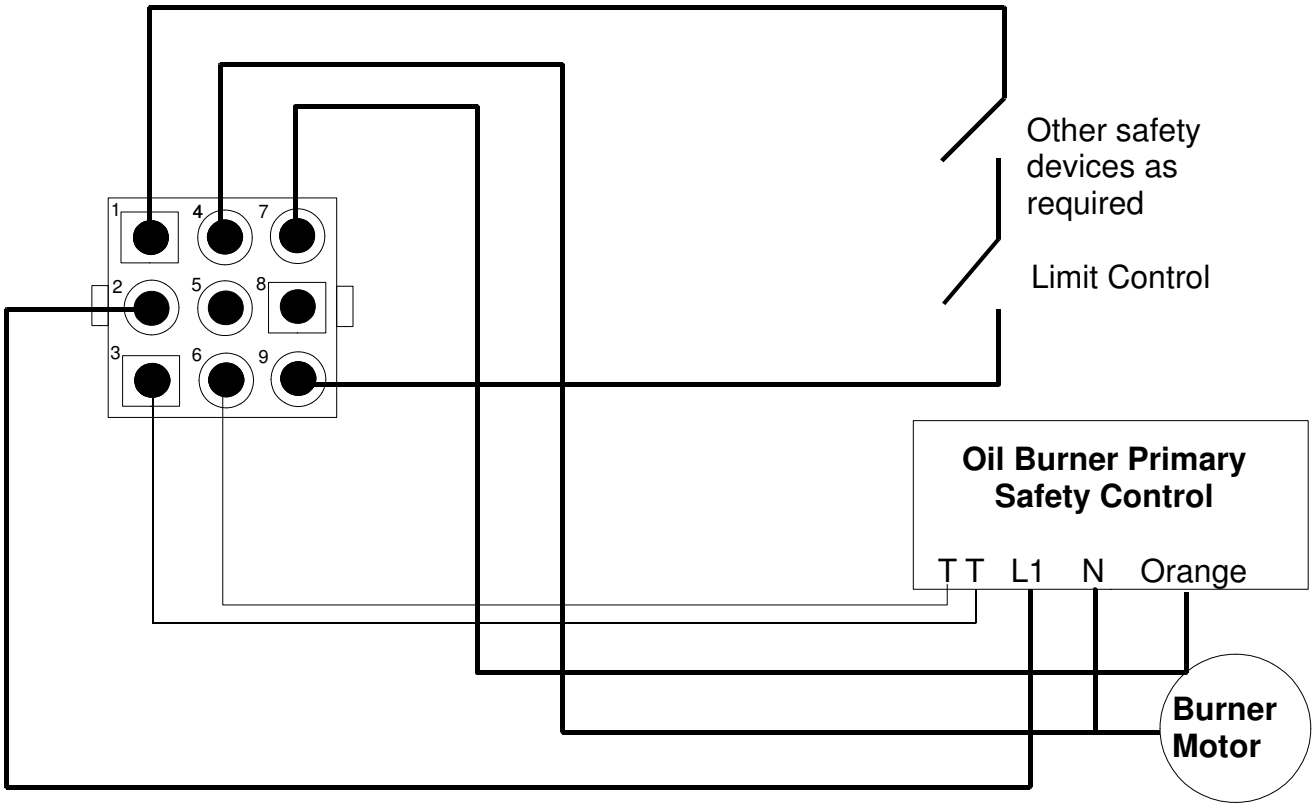
Riello, Standard



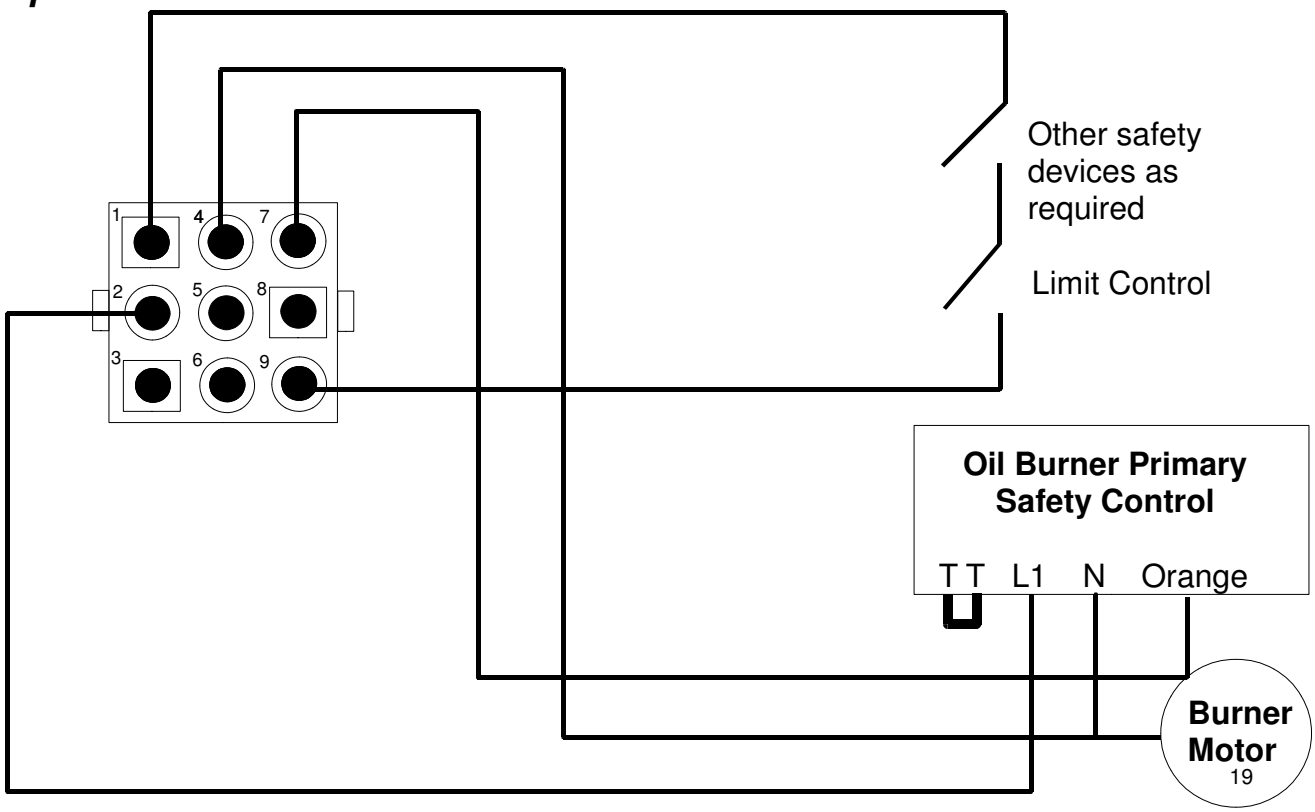
Riello, Post-purge



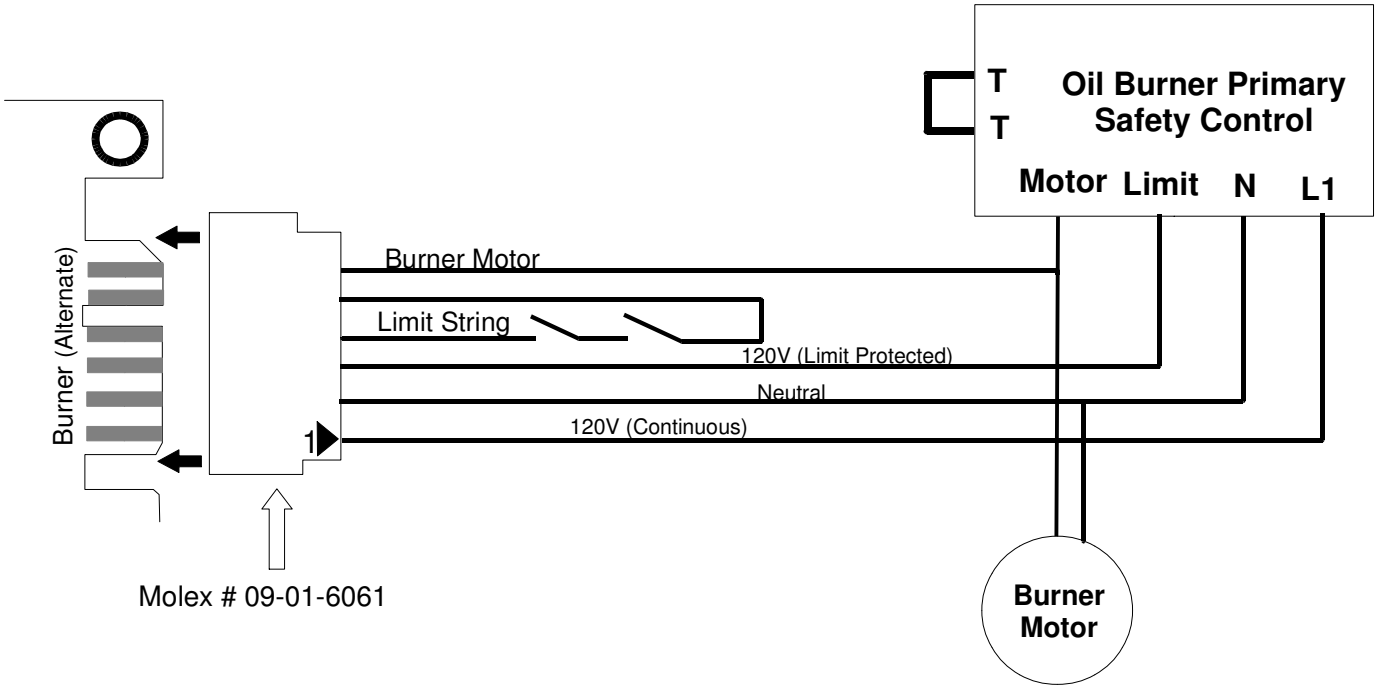
Beckett/Carlin (no post-purge)



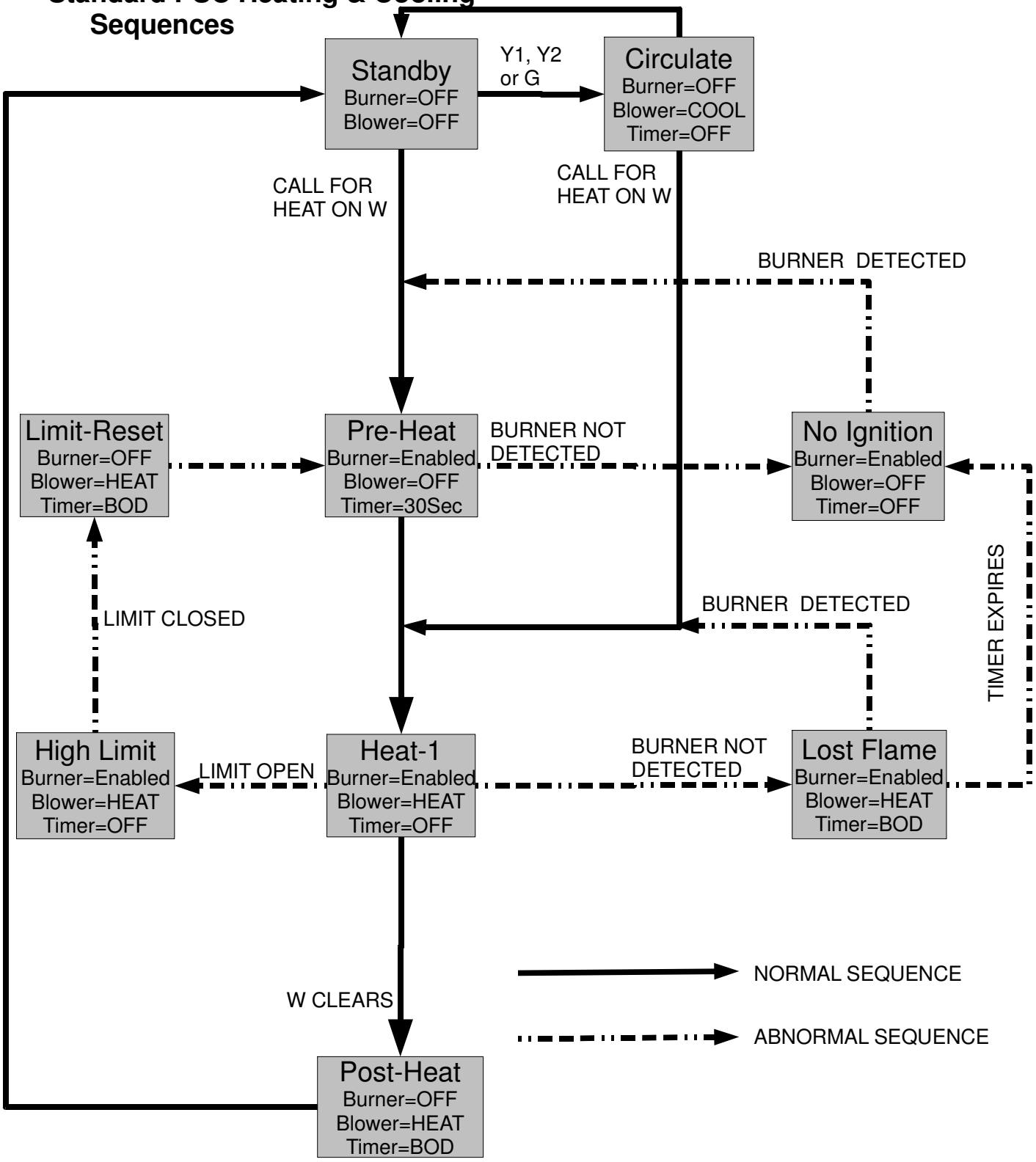
Beckett/Carlin (no post-purge)
Optional method



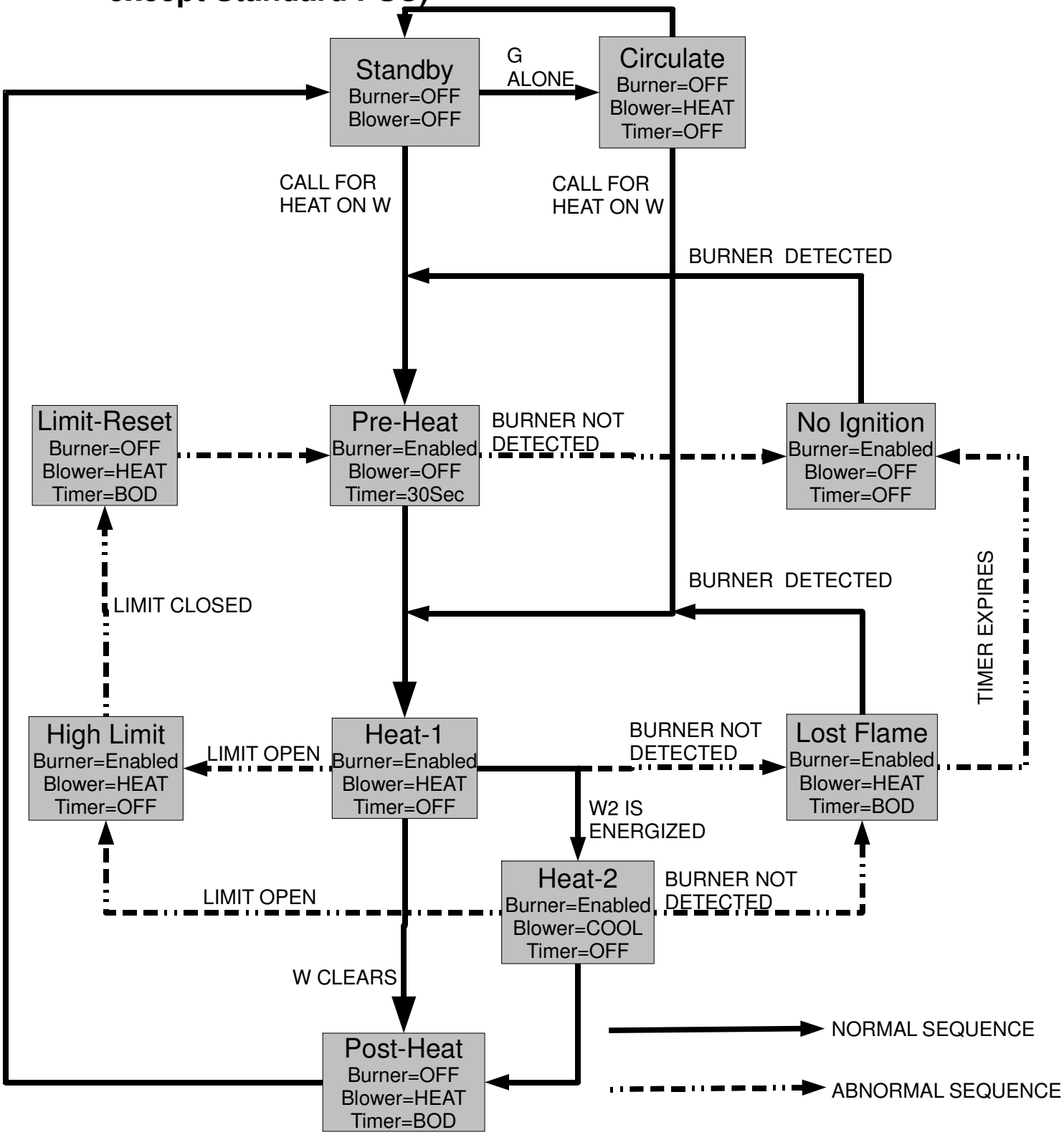
Beckett/Carlin with Post Purge (Alternate)



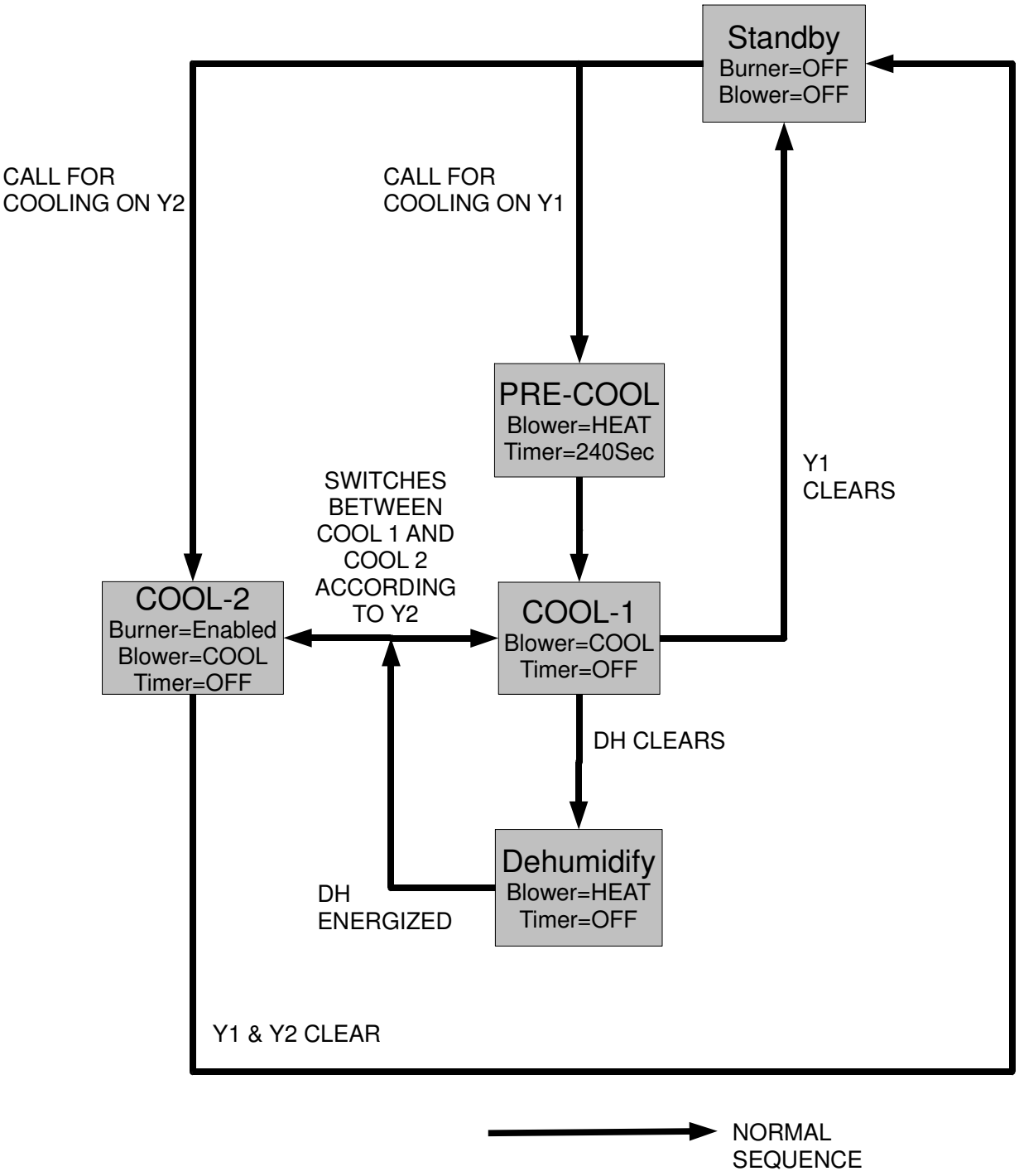
Standard PSC Heating & Cooling Sequences



Heating Sequence (all mode except Standard PSC)

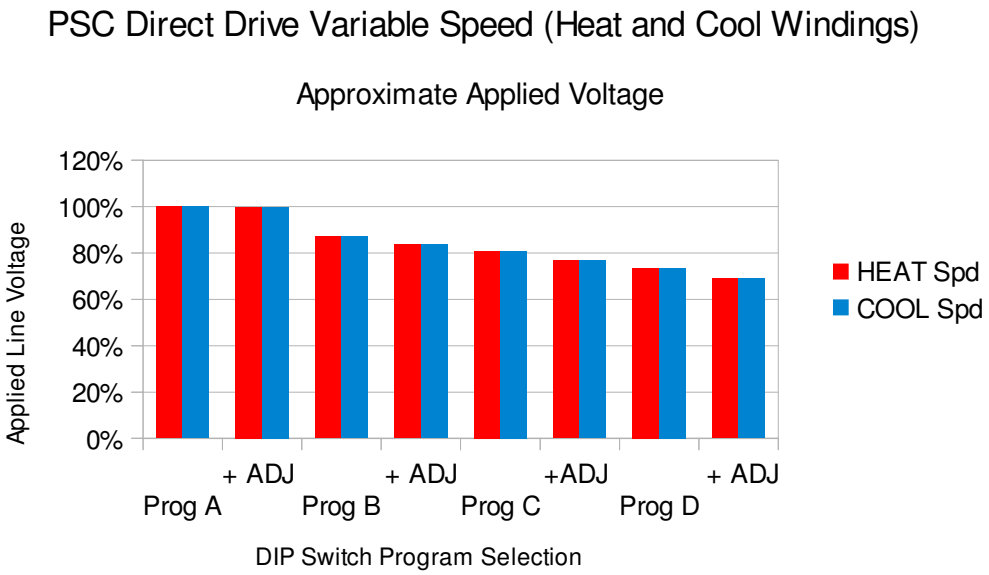


Cooling Sequence (all modes except Standard PSC)

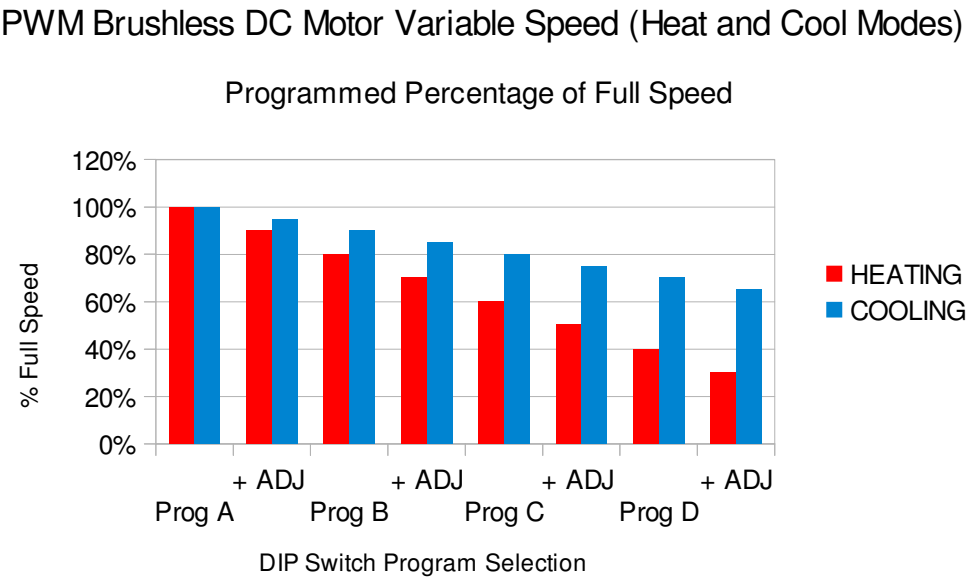


VARIABLE SPEED BLOWER CHARTS

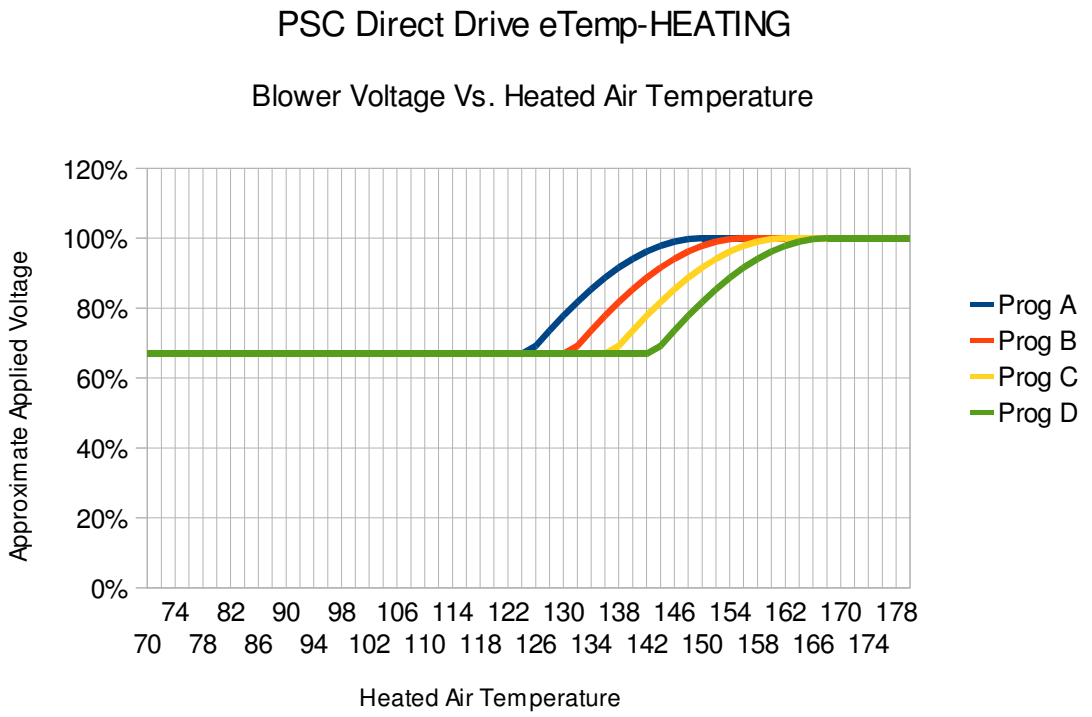
PSC Direct Drive Variable Speed Mode:

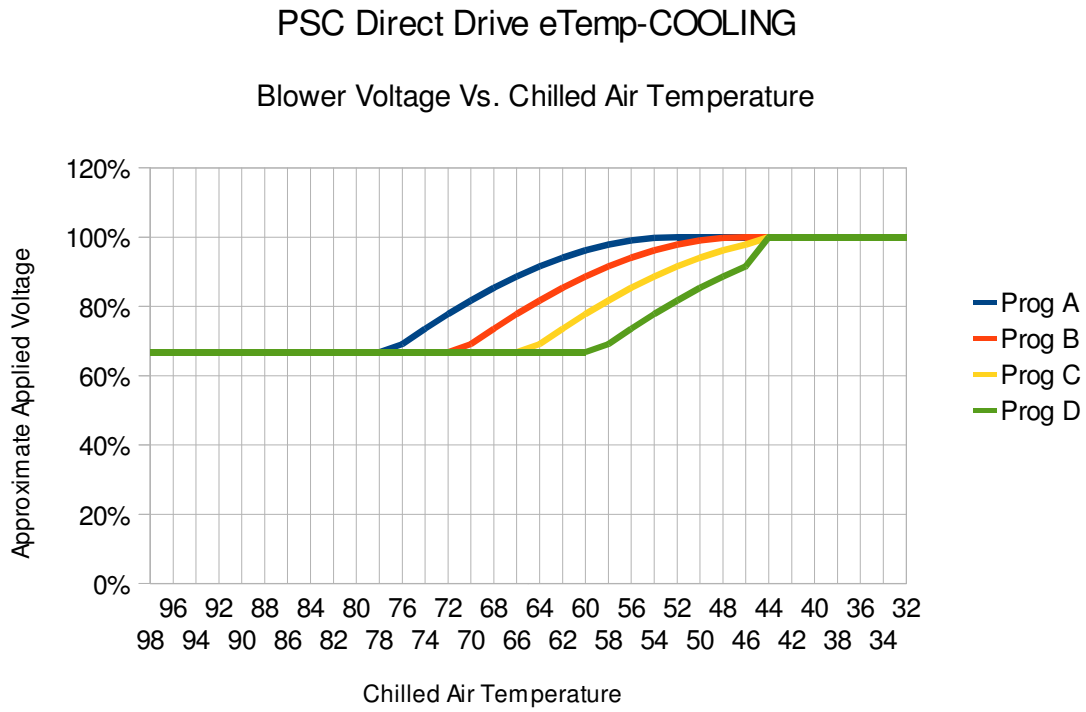


PWM (Brushless DC -Motor) Variable Speed Mode:



PSC "eTemp" (Direct Drive) Temperature-Modulation Mode:





PWM (Brushless DC Motor)"eTemp" Temperature-Modulation: